PATENT ABSTRACTS OF JAPAN

2

(11)Publication number : 08-300227
(43)Date of publication of application : 19.11.1996

(51)Int.CI. B23H 9/00

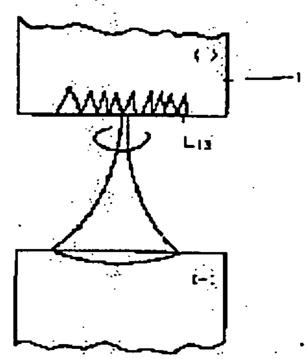
(21)Application number : 07-089050
(22)Date of filing : 14.04.1995

(71)Applicant : RES DEV CORP OF JAPAN
SAITO NAGAO
MITSUBISHI ELECTRIC CORP
MORI NAOTAKE

(72)Inventor : SAITO NAGAO
MORI NAOTAKE
FURUYA KATSUSHI
ISHIGURO TERUO
OIZUMI TOSHIRO
MAGARA TAKUJI

(54) ELECTRODE FOR ELECTRIC DISCHARGE MACHINING, AND METAL SURFACE TREATING METHOD BY ELECTRIC DISCHARGE

(57)Abstract:
PURPOSE: To eliminate the breakableness of a green compact electrode and also apply secondary machining to an article to be treated through only changing an electric discharge electric condition, by forming an electric discharge electrode with compression-molding carbide such as WC and Ti, boride such as TiB_2 and ZrB_2, and nitride such as TiN and ZrN to perform temporary sintering at a temperature of sintering temperature or lower to form an electrode for electric discharge machining.
CONSTITUTION: A simple substance or a mixture of two or more kinds, cited below, is compression-molded; carbide such as WC, TiC, TaC, ZrC, SiC, and VC; boride such as TiB_2 and ZrB_2, and nitride such as TiN and ZrN. Then, the compression molded body is temporarily sintered at a temperature of sintering temperature or lower to form an electric discharge electrode. In this electrode, the hardness of a surface layer is increased when machining is made by a plus electrode than by a minus electrode. This reason is estimated because of the fact that the electrode 1 in plus causes an article to be treated into minus to increase an electrode discharge trace current density to obtain the resulted article to be treated reheated at a high sintering temperature. Resultingly the breakableness of the electrode 1 is eliminated even in electric discharge machining having nonconsumptiveness.



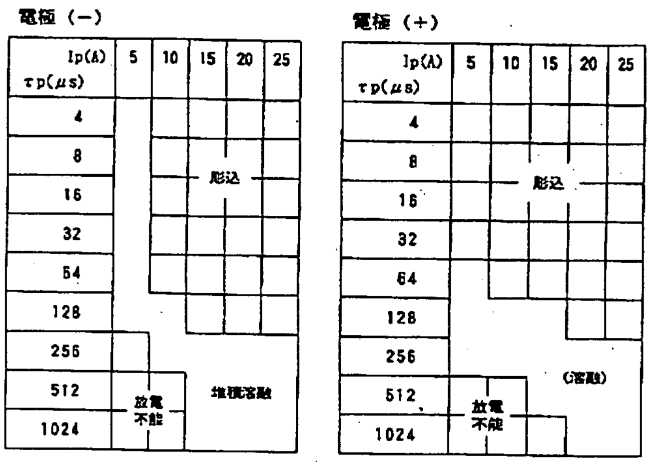
[JP,08-300227,A(1996)]

Japanese (PDF) File Wrapper Information

CLAIM + DETAILED DESCRIPTION TECHNICAL FIELD PRIOR ART EFFECT OF THE INVENTION TECHNICAL PROBLEM MEANS OPERATION EXAMPLE DESCRIPTION OF DRAWINGS DRAWINGS

[Translation done.]

Drawing selection | Representative drawing



[Translation done.]

Notes:
1. Untranslatable words are replaced with asterisks (****).
2. Texts in the figures are not translated and shown as it is.

Translated: 00:57:38 JST 11/24/2004
Dictionary: Last updated 10/12/2004 / Priority:

CLAIMS

[Claim(s)]
[Claim 1] carbide, such as WC, TiC, TaC, ZrC, SiC, and VC, TiB2, and ZrB2 etc. -- boride and TiNZrN etc. -- electrode for electric spark machining characterized by having pressed the simple substance of a nitride, or two or more sorts of mixture, having carried out the temporary-quenching join and constituting from temperature below sintering temperature.
[Claim 2] The electrode for electric spark machining characterized by having carried out the temporary-quenching join of the green compact of the easy ingredient of carbonization, such as Ti, V, and Ta, and constituting it from temperature below sintering temperature.
[Claim 3] Borides, such as carbide, such as WC, TiC, TaC, ZrC, SiC, and VC, TiB2, and ZrB2, [this] by performing electrodischarge treatment to processed material as a consumable electrode of an electron discharge method by pressing the simple substance of nitrides, such as TiN and ZrN, or two or more sorts of mixture, and carrying out a temporary-quenching join at the temperature below sintering temperature after that The metal finishing method by the discharge characterized by forming an enveloping layer in the above-mentioned processed material surface.
[Claim 4] The metal finishing method by the discharge which carries out the temporary-quenching join of the green compact of the easy ingredient of carbonization, such as Ti, V, and Ta, at the temperature below sintering temperature, and is characterized by performing electrodischarge treatment to processed material after that into the working liquid which produces carbon by the pyrolysis according this to discharge as a consumable electrode of an electron discharge method.
[Claim 5] The metal finishing method by the discharge according to claim 3 or 4 characterized by changing an electrode polarity and discharge electrical-and-electric-equipment conditions into the conditions which choose the conditions which an electrode material deposits in the 1st-step [to processed material] electrodischarge treatment, and go up a degree of hardness in the 2nd-step [to the above-mentioned processed material] electrodischarge treatment.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the metal finishing method by the electrode for electric spark machining and discharge which perform electrodischarge treatment to the processed material which needs corrosion resistance and abrasion resistance, such as metal mold, a tool, an internal combustion engine, and a gas turbine.
[0002]
[Description of the Prior Art] As indicated by the former, for example, JP,H5-148615,A It is 10 micrometers by the surface treatment by discharge. When the above thick enveloping layer is formed, Primary processing (deposition processing) is performed using the green compact electrode which consists of tungsten carbide powder, cobalt powder, etc. Next, the metal finishing method by the discharge which consists of two processes of exchanging for electrodes with comparatively little electrode wear (a nonconsumable electrode being called below), such as a copper electrode, and performing secondary elaboration (remelting processing) is known.
[0003] Although this method is a method which was extremely excellent in forming the large fine-ceramics layer of the adhesion force in a thickness of several 10 micrometers with higher hardness, it is necessary to exchange it to a nonconsumable electrode in secondary elaboration.
[0004] This conventional method is explained further. That is, it is difficult for an ingredient high-melting [, such as fine ceramics (WC, TiC, TaC, ZrC, SiC, TiB2, ZrB2, TiN, ZrN, etc.), and Tungsten W, Molybdenum Mo,] for you to make it fully spread to the interior of a work material only in a discharge deposit in many cases. The discharge deposit of the tungsten carbide of them (the following, WC, and description) is carried out as an example, and the example of an experiment which applied the pulse discharge treatment process to this is explained.
[0005] First, WC powder (mean particle diameter of 3 micrometers) is mixed at the end of iron powder (following and Fe powder and description) (mean particle diameter of 9.8 micrometers), and a rate of 1:1, and compression molding (compression pressure of 4t/square centimeter) is performed, it is considered as a green compact, this is pasted up on the copper round bar with electroconductive glue, and a green compact electrode is formed. Subsequently, carbon steel (S55C green wood) is made into processed material, and they are discharge electrical-and-electric-equipment conditions (pulse peak value Ip, pulse period taup, and pulse quiescent-time taur were changed, and it experimented with the usual die-sinking electric discharge machine shown in drawing 13 .).
[0006] In addition, in drawing 13 , 1 shows an electrode and 2 shows processed material and the power source with which a work tank and 4 supply working liquid, 5 supplies the servo mechanism of an electrode 1, and, as for 6, 3 supplies machining voltage between an

electrode 1 and the processed material 2.

[0007] As a result, although the arc by discharge concentrated and the green compact electrode 1 was destroyed in the processing conditions in which duty factor D is comparatively large, on 1.5% or less of conditions, it was stabilized, and duty factor D exhausted the green compact electrode 1, without collapsing, and adhered to the surface of the processed material 2. The processing conditions at that time are Ip=20A, taup=16microsecond, and taur=1024microsecond (this is called primary processing). Drawing 14 is the control circuit and 8, the resistance to which 9 restricts a transistor, 10, and the current that flows through 11 into each transistor 8 and 9, and 12 are a transistor 8 and a control circuit which controls the on-off action of 9. Moreover, drawing 15 is pulse-shape drawing showing the voltage waveform V in a working gap, and the current wave form Ip.

[0008] Next, pulse discharge processing is carried out in the following way to the processed material 2 obtained by the aforementioned electron discharge method. First, tungsten carbide powder and cobalt powder are mixed, the pressed WC-Co sintered compact (cemented carbide cutting tool ingredient) is pasted up on the copper round bar with electroconductive glue, and an electrode is constituted. Subsequently, pulse discharge processing is carried out using this electrode from on WC adhering to the surface of the processed material 2, and Fe deposit. Processing conditions considered the electrode polarity as minus, changed pulse peak value Ip, pulse period taup, and pulse quiescent-time taur, and were processed so that the processed material 2 might not be processed too much. If pulse period taup is short, the pulse peak value Ip is high and floor to floor time is long, the deposit of WC-Fe ****, but scattering of the deposit of WC-Fe can be lessened on the conditions that pulse period taup is slightly long and the pulse peak value Ip is a little low (this is called secondary elaboration).

[0009] Only by the discharge deposit of primary processing, although the adhesion force of WC-Fe was weak, when pulse discharge processing of secondary elaboration was performed to this, it was checked that WC is spread in processed material. Moreover, also in the case of (WC70, Co30), the degrees of hardness of the usual WC-Co sintered compact are Vickers hardness Hv850 - 950 intensity. In the above-mentioned example of an experiment, although there were little WC50 and WC of Fe50 and higher hardness, the degree of hardness (Vickers hardness Hv 1000-1400) (the hardening penetration of S55C is 800 or so Vickers hardness Hv) of the surface treatment layer of higher hardness was obtained rather than it. Moreover, the thickness which can obtain 1000 or more Vickers hardness Hv in the above-mentioned example of an experiment is 60 micrometers. Thickness is large at intensity.

[0010]

[Problem to be solved by the invention] In the conventional electrode for electric spark machining, when the duty factor D of discharge was large (ratio of pulse quiescent-time taur to pulse period taup), there was the 1st trouble that a green compact electrode might

collapse. In addition, besides the Reason which collapses while a green compact electrode processes it having the vulnerable organization which is doing compression adhesion Thermal conductivity and electric resistance become high seemingly, near a discharge point generates heat according to the discharge current, discharge concentration takes place, and it is thought for that near a discharge point is removed greatly, and the partial fusion re-coagulation (it happens by arc discharge) of an electrode that lack is generated.
[0011] Moreover, in the conventional electrode for electric spark machining, there was the 2nd trouble of there having been much consumption of an electrode because of a green compact electrode, and becoming deposition processing instead of remelting sintering.
[0012] Moreover, by the metal finishing method by the conventional discharge, it needed to exchange to the nonconsumable electrode by secondary elaboration, and when it switched to secondary elaboration conditions without exchanging an electrode, the electrode broke and there was the 3rd trouble that continuation of processing became difficult.
[0013] Here, the phenomenon by the size is described as the vocabulary of duty factor D. Duty factor D is D= pulse period taup/(pulse period taup+ pulse quiescent-time taur) (%); as shown in drawing 3 .
As shown in the above-mentioned formula, it is the rate of pulse period taup in 1 cycle (pulse period taup+ pulse quiescent-time taur) discharge, and a quiescent-time rate will be so short that this duty factor D is large, and machining efficiency will improve. However, if the average of the current per unit time becomes large, therefore saying that duty factor D is large has the high electric resistance of an electrode material and it is low, not only a discharge point but the temperature of the neighborhood of it will become high. [of thermal conductivity] If temperature is high, it will generate at the same point and insulating recovery and the discharge which is not enough, therefore is generated one after another will become intensive. It becomes what is called arc discharge (discharge without insulating recovery). Therefore, a specific discharge originating point collapses and it becomes what also has irregular electrode shape. The green compact electrode can do the need of taking the small (the above-mentioned example 1.5%) duty factor D.
[0014] It is what was made in order that the object of this invention might solve the 3rd trouble from the above 1st. While canceling the ease of collapsing of a green compact electrode, it aims at offering the metal finishing method by the electrode for electric spark machining and discharge which make secondary elaboration possible only by change of discharge electrical-and-electric-equipment conditions, without exchanging electrodes also on secondary elaboration conditions.
[0015]
[Means for solving problem] The electrode for electric spark machining concerning the 1st invention presses the simple substance of nitrides, such as borides, such as carbide, such as WC, TiC, TaC, ZrC, SiC, and VC, TiB2, and ZrB2, TiN, and ZrN, or two or more sorts of mixture, and a temporary-quenching join is carried out and it constitutes them from temperature below sintering temperature.

[0016] The electrode for electric spark machining concerning the 2nd invention carries out the temporary-quenching join of the green compact of the easy ingredient of carbonization, such as Ti, V, and Ta, and constitutes it from temperature below sintering temperature.
[0017] [the metal finishing method by discharge concerning the 3rd invention] Borides, such as carbide, such as WC, TiC, TaC, ZrC, SiC, and VC, TiB2, and ZrB2, Sintering support is added to a simple substance or two or more sorts of mixture, nitrides, such as TiN and ZrN, are pressed into them, a temporary-quenching join is carried out at the temperature below sintering temperature after that, and electrodischarge treatment is performed for this to processed material as a consumable electrode of an electron discharge method.
[0018] The metal finishing method by discharge concerning the 4th invention carries out the temporary-quenching join of the green compact of the easy ingredient of carbonization, such as Ti, V, and Ta, at the temperature below sintering temperature, and performs electrodischarge treatment to processed material after that into the working liquid which produces carbon by the pyrolysis according this to discharge as a consumable electrode of an electron discharge method.
[0019] In the 1st-step [to processed material] electrodischarge treatment, the metal finishing method by discharge concerning the 5th invention chooses the conditions which an electrode material deposits well, and changes an electrode polarity and discharge electrical-and-electric-equipment conditions into the conditions which go up a degree of hardness in the 2nd-step [to the above-mentioned processed material] electrodischarge treatment.
[0020]
[Function] Carbide, such as WC by this invention, TiC, TaC, ZrC, SiC, and VC, The electrode for electric spark machining which carried out the temporary-quenching join and which pressed the simple substance of nitrides, such as borides, such as TiB2 and ZrB2, TiN, and ZrN, or two or more sorts of mixture, and was constituted from temperature below sintering temperature can carry out an electron discharge method, without collapsing also in the electron discharge method of a non-exhausting polarity.
[0021] The electrode for electric spark machining which carried out the temporary-quenching join of the green compact of the easy ingredient of carbonization, such as Ti by this invention, V, and Ta, and constituted it from temperature below sintering temperature can carry out an electron discharge method, without collapsing also in the electron discharge method of a non-exhausting polarity.
[0022] Carbide, such as WC by this invention, TiC, TaC, ZrC, SiC, and VC, [nitrides, such as borides, such as TiB2 and ZrB2, TiN, and ZrN,] Add and press sintering support into a simple substance or two or more sorts of mixture, and After that, A temporary-quenching join is carried out at the temperature below sintering temperature, and the metal finishing method of performing electrodischarge treatment to processed material as a consumable electrode of an electron discharge method can carry out the electron discharge method of

this, without an electrode collapsing also to polar conversion or wide range discharge electrical-and-electric-equipment conditions.

[0023] The temporary-quenching join of the green compact of the easy ingredient of carbonization, such as Ti by this invention, V, and Ta, is carried out at the temperature below sintering temperature. Then, the metal finishing method of performing electrodischarge treatment to processed material into the working liquid which produces carbon by the pyrolysis according this to discharge as a consumable electrode of an electron discharge method can carry out an electron discharge method, without an electrode collapsing also to polar conversion or wide range discharge electrical-and-electric-equipment conditions.

[0024] The conditions which an electrode material deposits well in the 1st-step [to the processed material by this invention] electrodischarge treatment are chosen. An electrode does not collapse and the metal finishing method of changing an electrode polarity and discharge electrical-and-electric-equipment conditions into the conditions which go up a degree of hardness in the 2nd-step [to the above-mentioned processed material] electrodischarge treatment can perform the treatment process of deposition, remelting, and a lump [carve].

[0025]

[Working example]

Below example 1. explains one example of this invention about drawing. First, creation of an electrode is explained. In the electrode of only compacting like before, since the electrode might collapse on secondary elaboration conditions, after mixing and pressing tungsten carbide powder and cobalt powder (powder of WC-Co), the temporary-quenching join was carried out at this example. Each condition is as being shown in a table 1.

[0026]

[Table 1]

粉体	粒　度	混合比	成形圧力	焼結温度
WC	１．０μｍ	６０重量％	１０ｔ／㎠	真空炉　１１００℃ 昇温１１時間　保温３０分 降温４８時間
CO	１．３８μｍ	４０重量％		

[0027] Next, processed material is set to SK-3, the green compact electrode of the temporary-quenching join which showed the surface to the grinding side and showed the electrode in the above-mentioned table 1 is used, and surface treatment by an electron discharge method is performed. Quiescent-time taur set [the current value Ip] constant 5-25A and pulse period taup with 1024 microseconds for 4 to 1024 microseconds.

[0028] Drawing 1 shows the pulse peak value, the pulse quiescent time, and the processing state at the time of switching an electrode to minus and plus, respectively, and if an electrode is minus, it has the field deposited to processed material. The inside of this drawing 1 and a horizontal train are pulse peak value IP, and a column is pulse period tauP. Processing processed material, without depositing shows and it sometimes process

with "****." Such a **** field is removable choosing discharge electrical-and-electric-equipment conditions and by lowering sintering temperature. If an electrode is plus, remelting processing can be performed for what the electrode deposited in minus. If a **** field chooses discharge electrical-and-electric-equipment conditions or sintering temperature is lowered like the above, it is removable. Moreover, in the direction at the time of processing it by plus, a degree of hardness rises rather than the degree of hardness of a surface layer when an electrode processes it by minus.

[0029] If an electrode is plus, the discharge marks current density of processed material will become high, and this Reason will be considered because a result which was reheated at high sintering temperature is brought, as processed material is subtracted and it is shown in assumption model drawing to the behavior of the arc column of drawing 2 , and discharge marks formation. In addition, 13 of drawing 2 shows the expandable part of the electrode at the time of making an electrode 1 into negative polarity. Drawing 3 shows this surface treatment layer's cross-sectional hardness distribution.

[0030] In addition, drawing 4 - drawing 7 are what shows the cross section of the processed material which performed surface treatment. The processing layer cross section and drawing 6 which drawing 4 was switched to the surface treatment cross section for floor-to-floor-time 30 minutes, and drawing 5 switched the polarity of the electrode to minus and plus, and carried out the electron discharge method show the processing layer cross section of variant-shaped processed material, and drawing 7 shows the cross section of the processing layer of a weld zone, respectively.

[0031] As shown in the above example, it is clear that the WC-Co electrode's which carried out the temporary-quenching join the following properties are shown. Even if it carries out a temporary-quenching join, there is a field which deposits an electrode to negative polarity, then processed material. Although positive polarity, then deposition are not carried out, what was once deposited can be remelted and a degree of hardness can be raised.

[0032] It became clear that discharge was continuable without collapsing, whether an electrode does not collapse even if it changes a polarity into plus and minus, and it repeats a dipole inversion or it repeated frequently at high speed.

[0033] Moreover, a duty factor can be collapsed very much highly, or it is [stop / **************] easy to concentrate discharge, and processing efficiency can be raised.

[0034] It is clear also from another experiment like a green compact that unlike what only touches the combination in fine particles becomes strong by a temporary-quenching join, electric resistance becomes small, and thermal conductivity is also high. Of course, electric resistance is high and the thermal conductivity of a low thing is more natural than what was sintered thoroughly (high temperature processing).

[0035] If the above-mentioned example is explained further, and a green compact is heated to sintering temperature like sintering of the usual sintered alloy or fine ceramics, a firm sintered compact will be done, but then an electrode serves as non-expendable and it becomes impossible to cause deposition to processed material. Therefore, sinter the

means which this invention person chose at temperature lower than (1) sintering temperature.

(2) Endowment of the opposite property of expendability and non-expendable is conversion of an electrode polarity, and change of the discharge electrical-and-electric-equipment conditions at that time, and hit on an idea of it from assumption (temporary construction of an artificer) of the arc model of discharge generating shown in drawing 2 .

[0036] The matter of the above (1) is explained here. The general tendency of sintering is shown in drawing 8 , sintering time amount is shown on an axis of abscissa, and relative density is shown on the axis of ordinate. If it sinters at an elevated temperature, theoretical relative density will be approached, but if it sinters at temperature lower than it, low relative density, i.e., reinforcement etc., will become low. Drawing 9 shows the sintering temperature of alumina ceramics, and the consistency of appearance, sintering time amount is shown on an axis of abscissa, and the consistency of appearance is shown on the axis of ordinate by it. If it sinters above 1600 degrees C, theoretical density will be approached remarkably. In this invention, rather than full sintering, it becomes the range where 50% - about 90% of theoretical density is used, and it becomes stronger enough than as [green compact] by **** enough, and electric resistance is also small and thermal conductivity also serves as size.

[0037] Next, the matter of the above (2) is explained. Although primary processing is performed on the conditions which an electrode exhausts and secondary elaboration is performed on the conditions of electrode wear which become small, consumption of an electrode can be controlled by choosing a polarity to be shown in assumption model drawing to the behavior of the arc column of drawing 2 , and discharge marks formation. That is, when an electrode is minus, the arc column by discharge of one shot has the thin minus side, as shown in drawing, and the plus side becomes thick. Since the discharge current is constant, the discharge marks current density by the side of minus becomes remarkably high, and the consumption by the side of minus increases.

[0038] Conversely, since, as for the plus side, discharge marks current density becomes low relatively, consumption decreases. Therefore, what is necessary is just to take a large discharge current value, in order to make current density of discharge marks into size further, while making a polarity minus to exhaust an electrode remarkably.

[0039] Moreover, what is necessary is to consider an electrode polarity as plus and just to lower the current value of discharge marks, in order to make an electrode non-expendable. In order it is long in current pulse time amount taup in order to make it un-exhausting, since the current density of the discharge marks of one shot becomes low so that current pulse time amount taup is long, and to consider it as positive polarity and to make it an ablation form, it will be short and what is necessary will be just to make current pulse time amount taup into negative polarity.

[0040] The following new examples can be produced based on the property more than example 2. That is, the polarity of an electrode is repeated to minus and plus by several 10

times of frequency in 1 minute. The degree of hardness of a processed surface rises more by this processing method. Moreover, a thick surface layer can be made. Or an enveloping layer with minutely thick machined surface granularity can be formed.

[0041] After processing a temporary-quenching join electrode into the object configuration by machining or ultrasonic machining, a mold cavity is made by making this into a process electrode (a configuration is carved). The positive polarity electrode of the polarity at this time with little consumption improves the accuracy of form of configuration processing. Next, deposition processing is performed by considering the polarity of an electrode as minus (primary processing). Remelting processing is performed to the degree by considering the polarity of an electrode as plus. If it does in this way, even if it does not use a conventional copper electrode or a conventional graphite electrode, configuration processing of a cavity can be performed and hard facing can be performed after that.

[0042] [a processed ingredient / with the electrode which carried out the temporary-quenching join of the ingredient with easy carbonization, such as TiC, Ti, or V or Ta, for the surface of a thing like the ingredient whose melting point is higher than about 1500 degrees C, for example, the nature alloy of superhard,] like steel If it is processed converting an electrode polarity, to steel, deposition and remelting sintering will be attained also in the field to carve.

[0043] If discharge surface treatment is performed lubricating at the same time it makes a temporary-quenching join electrode into the shape of a wheel (disc-like) and gives a revolution, as shown in drawing 10 , it is processible, improving circulation of working liquid. Moreover, since the amount which a temporary-quenching join electrode exhausts can be distributed to the whole disk, it is useful to hardening of a cutting tool or components processing. That is, it is synonymous with it being useful to perform a cutting tool and components processing by a grinder.

[0044] In drawing 10 , the insulating spindle with which a rotary wheel and 22 rotate working liquid, 23 rotates a power source, and, as for 24, processed material and 21 rotate [20] an electrode 21, and 25 show a brush, and 26 shows the revolution belt. In addition, drawing 11 is the sectional view of a wheel 21, and 27 shows the electrode with which the wheel 21 was equipped.

[0045] In addition, when a temporary-quenching join electrode performs hard facing with regrinding of a cutting tool, the structure united with the diamond grinding wheel can also be taken. That is, the periphery section of a diamond wheel is used for resharpening, and the structure of sticking a temporary-quenching join electrode on the inner circumference section is taken.

[0046] Drawing 12 shows the sectional view and the diamond with which the wheel was equipped with 30 and the wheel 30 was equipped with 31, and 32 show the temporary-quenching join electrode in drawing 12 .

[0047]

[Effect of the Invention] [the electrode for electric spark machining by the 1st invention] as

explained above Borides, such as carbide, such as WC, TiC, TaC, ZrC, SiC, and VC, TiB2, and ZrB2, Since the simple substance of nitrides, such as TiN and ZrN, or two or more sorts of mixture were pressed, and the temporary-quenching join was carried out and it constituted from temperature below sintering temperature after that, an electrode does not collapse to polar conversion or wide range discharge electrical-and-electric-equipment conditions.

[0048] Moreover, since the electrode for electric spark machining by the 2nd invention carried out the temporary-quenching join of the green compact of the easy ingredient of carbonization, such as Ti, V, and Ta, and constituted it from temperature below sintering temperature, an electrode does not collapse to polar conversion or wide range discharge electrical-and-electric-equipment conditions.

[0049] [moreover, the metal finishing method by discharge by the 3rd invention] Borides, such as carbide, such as WC, TiC, TaC, ZrC, SiC, and VC, TiB2, and ZrB2, [this] by performing electrodischarge treatment to processed material as a consumable electrode of an electron discharge method by adding sintering support to a simple substance or two or more sorts of mixture, pressing nitrides, such as TiN and ZrN, into them, and carrying out a temporary-quenching join at the temperature below sintering temperature after that Since the enveloping layer was formed in the above-mentioned processed material surface, if an electrode does not collapse to polar conversion or wide range discharge electrical-and-electric-equipment conditions and an electrode is used continuously, an electrode surface will be sintered and a degree of hardness will be increase-ized.

[0050] [moreover, the metal finishing method by discharge by the 4th invention] [carry out the temporary-quenching join of the green compact of the easy ingredient of carbonization, such as Ti, V, and Ta, at the temperature below sintering temperature, and] after that since electrodischarge treatment is performed to processed material into the working liquid which produces carbon by the pyrolysis according this to discharge as a consumable electrode of an electron discharge method If an electrode does not collapse and an electrode is continuously used after acting deposition, remelting, etc. enough also to polar conversion or wide range discharge electrical-and-electric-equipment conditions, an electrode surface will be sintered and a degree of hardness will be increase-ized.

[0051] [moreover, the metal finishing method by discharge by the 5th invention] Since an electrode polarity and discharge electrical-and-electric-equipment conditions are changed into the conditions on which an electrode material chooses as the conditions deposited well, and goes up a degree of hardness in the 2nd-step [to the above-mentioned processed material] electrodischarge treatment in the 1st-step [to processed material] electrodischarge treatment, an electrode does not collapse and the treatment process of deposition, remelting, and a lump [carve] can be performed.

[Translation done.]